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ABSTRACT

The role of achievement in mathematics during high school is a critical barrier for women. Very few who were not planning a math-related career in the 12th grade later switch into a math-related career. Math skills are highly correlated with math-related career plans, and math skills developed during high school are both an essential component of subsequent educational attainment and a significant predictor of success in establishing math-related careers independent of level of educational attainment. Only minimal sex differences in math achievement are apparent in ninth grade, but dramatic sex differences are measured in math achievement gains during the high school years. These differences are attributable to a greater participation by males in elective math courses and a greater male interest in math-related careers. (Author/PJC)

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THE ROLE OF MATHEMATICS IN WOMEN'S CAREER DEVELOPMENT

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The Role of Mathematics
In Women's Career Development

The levels of career achievement reached by men and women in our society are grossly unequal. The 1970 U.S. census shows that men in the labor force had median annual earnings of $7,600, while the median for women was below $3,650. Among professional and technical workers, males had median earnings of $10,735, compared to a median of $6,034 for females (U.S. Bureau of the Census, 1975). These differences result, in large part, from a clear pattern of occupational segregation by sex. Males are widely distributed across a wide range of careers, including the entire range of higher-paying professions such as law, medicine, business management, science, and engineering. Female professionals, however, tend to be clustered into a relatively small number of generally lower-paying careers, specifically in teaching and nursing.

The extent of this pattern of segregation can be seen in many occupations in this country. For example, in 1970 only about 1% of the engineers, 2% of the computer specialists, 16% of the physical scientists, and 20% of the life scientists were women (U.S. Bureau of the Census, 1973). The imbalance seems to be due to a failure to prepare women for entry into male-dominated professions. During the period 1969 through 1975, women earned fewer than 1% of the doctorates in engineering and fewer than 10% of the doctorates in mathematics, physical sciences, and business administration (McCarthy & Wolfe, 1975). Similar imbalances can be found in the proportions of men and women who earned undergraduate degrees in male-dominated fields.

One of the most significant early barriers to women's pursuit of these professions is the lack of sufficient education in mathematics. Sells (1973) found a high correlation between the amount of mathematics required in degree programs at the University of California at Berkeley and the ratio of males to females in those programs. At the same time, she found that 54% of the entering undergraduate men had taken 4 years of high school mathematics, while only 8% of the women were similarly prepared. These findings led Sells to suggest that math training is the "critical filter" that effectively screens women from many professions.

The present study is a detailed examination of factors that contribute to the enormous sex differences in the pursuit of math-related careers. The study uses data from Project TALENT, a massive nation-wide longitudinal study of young men and women in their 30's who are just now becoming established in their careers. The two general objectives of the study are to (1) investigate antecedents of decisions to take elective math courses in high school and the effect of these decisions on math achievement gains during high school and (2) document the importance of high school math achievement in subsequent career decisions.

Within the general objectives of the study, the following more specific questions are addressed:

1. To what extent were sex differences in math achievement evident during the high school years?

2. To what extent could sex differences in math achievement during high school be attributed to sex differences in participation in elective math courses?

3. To what extent could sex differences in math participation and achievement during high school be accounted for by differences, abilities, interest, and plans already evident in ninth grade?

4. To what extent were sex differences in the development of math-related careers reflected in sex differences along the educational paths leading to such careers?

5. How important and accurate were early career plans with respect to the developmeht of math-related careers?

6. To what extent was high school math achievement predictive of success in the pursuit of math-related career goals?

Background

Sex Differences in Math Achievement

Sex-related differences in math achievement have been reported again and again in the research literature. Some researchers have called the differences "overwhelming" (Mullis, 1975), while others have described them as "minimal" (Fennema & Sherman, 1977a). The latter have suggested that there may be no real sex differences in math aptitude, and that many of the reported differences in achievement result from a failure to control for the number and nature of math courses taken by students in the various studies.

Several of the findings, however, suggest differences that are too large to dismiss without further investigation. In an analysis of data on students from the Educational Testing Service Growth Study, Hilton and Berglund (1974) found significant sex differences in math achievement favoring males. These differences began for academic students in Grade 7 and for non-academic students in Grade 11.

One of the most frequently suggested contributors to sex differences in math achievement is the sex role socialization of males and females. The major research in this area has been summarized by Fox (1976). Mathematics has often been described as a "male domain" (Aiken, 1975; Astin, 1974; Fennema & Sherman, 1977a). Precisely when and where such stereotyping begins is a matter of debate. Stein and Smithells (1969) gave evidence that students did not consider math a "masculine" subject until they reached adolescence. Fennema (1976) found that female high school students denied that math was a sex-stereotyped subject, yet behaved as though math were for males by their avoidance of elective math courses. Horner (1972) suggested that females were motivated to avoid success in traditionally "male" areas such as math. Aiken (1975, 1976) suggested that sex differences in math ability were partially a consequence of same-sex modelling by girls, who had few female role models for success in mathematics, and Maccoby and Jacklin (1974) concluded that same-sex models were the most potent for stimulating imitative behavior; hence, girls tended to imitate their verbally-oriented mothers, while boys emulated their quantitatively-oriented fathers.

A related factor that may underly sex differences in math achievement is the perceived usefulness of math for later careers, which Haven (1972) found to be one of the most significant predictors of decisions by gifted high school girls to take or not take elective math courses. Haven found the girls less likely than their male counterparts to perceive math as relevant to their career goals. Fennema and Sherman (1977b) also found that the perceived usefulness of math was related to the election of math courses. In addition, they found significant sex differences in achievement in schools where there were also significant sex differences in the perceived usefulness of math. These differences in perceived usefulness may reflect the different career orientations of males and females (Fox,

1976) or they may result from a lack of sufficient information. Fennema and Sherman (1977b) suggested that girls were unaware that mathematics was relevant to many careers besides purely scientific ones.

The Development of Math Related Careers

A large number of studies of the development of science careers have consistently found mathematics to be of critical importance. (See Rever, 1973, for a review of many such studies.) Several studies have examined the characteristics of scientists (primarily male scientists) when they are well along in their careers. (See, for example, the works of Roe, 1951a, 1951b, 1953). Of greater relevance for today's young women, however, are studies of the characteristics in high school of women who later became scientists. Astin (1970) used TALENT follow-up data on young women who had been in the 12th grade in 1960 to find predictors of their career plans five years after high school. She found that scholastic aptitude (particularly mathematics) and SES were the best predictors of plans for science, "professional," and teaching careers and that traditionally masculine interests and aptitudes differentiated women planning scientific and "professional" careers from those choosing teaching, the health fields, and office work. Analyses of these women's post high school experiences emphasized the importance of additional education and marital status of predictors of women's career decisions.

Procedures

The present study was divided into two phases. Phase I used data on a subset of the 1960 TALENT participants who were tested and surveyed both in 1960 (as 9th graders) and in 1963 (as 12th graders) to examine factors influencing math gains during high school. Phase II used the data on the TALENT participants who were tested as 12th graders including data gathered in follow-up surveys conducted one, five, and eleven years after high school. Table 1 shows how the data analyzed in the present study fit into the TALENT data collection schedule as a whole.

Samples

The procedures used to select the original sample of TALENT participants are described in detail in Chapter 2 of The Project TALENT Data Bank Handbook (Wise, McLaughlin, and Steel, 1977). Briefly, a cluster

TABLE 1

Modal Age of Respondents in Relation to
TALENT Data Collection Schedule

Data Collection Date	High School Class				Data Collection Effort
	1960	1961	1962	1963	
1960	17½	16½	15½	14½	Initial Testing
1961	19				
1962		19			
1963			19	17½[a]	1-Year Follow-Up
1964				19	
1965	23				
1966		23			
1967			23		5-Year Follow-Up
1968				23	
1969					
1970					
1971	29				
1972		29			
1973			29		11-Year Follow-Up
1974				29	
1975					

Note. All dates are for the Fall except the 1960 testing which was in the Spring.

a. Approximately 7,500 students retested as high school seniors.

sampling approach was used with American high schools as the primary sampling unit. All American high schools were stratified by geographic region (8 USOE regions with the 5 largest cities treated separately), by type of school (private, parochial, or public with the public schools divided into 4 groups based on enrollment) and by retention ratio (the ratio of graduates to 10th graders). Within each of the cells thus defined, schools were selected randomly, with 1/12 of the large public schools, 1/50 of the very small public schools, and 1/20 of all other schools being chosen. Approximately 93% of the schools so chosen agreed to participate in the study. All of the students, in each of the 987 participating schools, were included in the TALENT probability sample, a total of over 375,000 students. (Approximately 65,000 additional students in special supplemental samples were also tested.)

The Phase I analyses are based on a special sample of roughly 7,500 9th-grade students in 1960 who were retested as 12th graders in 1963. In selecting the retest sample, all of the 1960 TALENT schools were sorted into groups based on type of school (public vocational, public nonvocational, nonpublic). The public nonvocational schools were further sorted by city size (6 levels) with the schools from large and very large cities sorted on "economic level" and the others sorted further on region. Schools were then sampled from each of the "public school" cells in this taxonomy. In all, 118 schools participated in the study, with all of the seniors in each school included in the retest sample. Roughly 75% of those tested were found to have been tested in 1960, the other 25% being transfers or accelerated students.

In order to shorten the required testing time, six different and overlapping forms were used, each form containing about half of the 1960 test material. For purposes of the proposed study, Form D is of primary interest since it contains both student background information (including math courses taken) and scores on the math information and ability tests Approximately 1,100 of the students tested in 1960 completed Form D. This sample includes students from nearly all of the public school categories in the school taxonomy. Data collected with Forms A and E were also used in analyses focusing on math participation only.

A complete description of the 1963 retest study including the sample design, the instruments used, a discussion of the reliabilities of these instruments, and general findings of the study is given in The High School Years: Growth in Cognitive Skills (Shaycoft, 1967).

The Phase II analyses are based on the TALENT 12th grade "complete data" sample. This sample consists of 12,759 of the TALENT participants tested as 12th graders, who supplied data in all three follow-up surveys. This sample heavily overrepresents the more academically able students in the original TALENT sample since they were significantly more likely to respond to the follow-up surveys. In one sense this oversampling is advantageous to the present study which concerns careers that require high levels of academic skills. However, it is also essential that this sample be weighted so that estimates of national norms can be produced where appropriate.

Several steps were taken to generate appropriate case weights and assure their accuracy. Each of the follow-up surveys included an intensive follow-up sample of roughly 2,500 participants who failed to respond to the mail survey. The intensive sample cases were tracked down and interviewed by telephone. In general, over 90% of the intensive sample members were located, and interviews were obtained from over 90% of those located. In addition to adjusting the weights to reflect this subsampling of non-respondents, the TALENT staff developed statistical corrections for the small amount of nonresponse in these intensive samples. (See McLaughlin, Fulscher, and Yen, 1974). Finally the "complete data" cases were stratified by sex, race, 12th grade academic aptitude, socioeconomic status, and 11-year post-high school occupation group, and their weights further adjusted to reflect differences in completion rates between the various cells in this design.

Study Variables

The variables analyzed in this study are questionnaire items and test scores selected from the following sources:

- the 1960 student questionnaire and test battery
- the 1960 school characteristics questionnaire
- the 1963 retest questionnaire and test battery

- o the 1-year follow-up questionnaire for the 12th grade cohort
- o the 5-year follow-up questionnaire for the 12th grade cohort
- o the 11-year follow-up questionnaire for the 12th grade cohort.

The Project TALENT Data Bank Handbook (Wise, McLaughlin, and Steel, 1977) includes a description of each of the tests and reproductions of each of the questionnaires except the 1963 Student Information Blank.

The following variables are of particular importance in the findings reported here:

Math achievement. The math achievement measure used in this study was a 54 item test including 16 "word problem" items designed to measure arithmetic reasoning, 24 introductory math items primarily covering elementary algebra and number theory, and 14 advanced math items covering topics generally taught in grades 10 through 12 including plane geometry, analytic geometry, trigonometry, and elementary calculus.

Math participation. The measure used was the number of math courses marked in the 1963 Student Information Blank. The list included first year algebra, plane geometry, second year algebra, solid geometry, trigonometry, and analytic geometry or calculus. Scores on this measure ranged from 0 to 6. This measure was found to have higher predictive validity than an alternative measure of math participation based on the "highest level" course marked.

Math level of careers and career plans. Some initial analyses were done in defining the math level of careers or career plans. Three indicators of the amount of college and high school math typically taken by those in each career were developed. Table 2 shows these indicators and the resultant classification of careers into 6 levels of math. Careers at levels 4, 5, and 6 mostly require some college math and so are grouped together and labeled "math-related" careers in some analyses. Careers at level 3 generally require college participation and may require some statistics but do not require calculus or other college math. They are used as an "intermediate" level in many analyses to provide a comparison group with a level of education somewhat comparable to the "math-related careers." Level 1 and 2 careers are grouped together as low math-level careers in many of the analyses.

TABLE 2

The Math Level of Careers as Defined by Three Required Math Education Indicators

Career Plan (No. of cases) (1-year Follow-Up)	Indicator: College Math (% in 1st year math & earning high grades)	Indicator: College Math (% taking or planning to take college math)	Indicator: High School Math (% taking more than 2 years)
Level 6:			
Mathematician (86)	88	92	92
	*		
Level 5:			
Engineer (682)	76	87	90
Physical Scientist (184)	75	90	92
Architect (73)	71	88	77
Pilot (13)	69	92	85
	*		
Level 4:			
Pharmacist (70)	65	87	80
Dentist (68)	63	79	87
Physician (264)	61	87	89
Biological Scientist (109)	59	86	75
Armed Forces Officer (38)	59	72	87
	*		
Level 3:			
Forester (38)	45	68	61
Lawyer (183)	43	67	84
College Professor (73)	48	62	77
Engineering Aide (15)	43	57	67
Medical/Dental Technician (145)	40	58	50
Accountant (402)	40	48	55
High School Teacher (1427)	39	57	62
Elementary Teacher (587)	40	57	54
Sociologist/Psychologist (97)	34	70	68
Political Scientist/Economist (80)	32	48	74
Businessman (398)	33	51	58
Librarian (22)	36	55	59
Clergyman (106)	34	49	55
Writer (94)	26	45	62
Social Worker (95)	25	46	47
		*	
Level 2:			
Nurse (490)	7	9	50
Salesperson (97)	22	31	51
Policeman/Fireman (58)	4	19	41
Armed Forces Enlistedman (73)	15	29	51
Artist/Entertainer (160)	6	23	41
Farmer (187)	18	31	34
Skilled Worker (418)	10	12	49
Structural Worker (82)	12	15	38
			*
Level 1:			
Secretary/Office Worker (972)	6	8	17
Barber/Beautician (173)	1	1	14

* Denotes gap in indicator values that were used in defining the 6 levels.

Math level of college majors. College majors were classified into the same 6 math levels used in classifying careers. The 6 levels were collapsed into three groups, math-related, intermediate math level, and low math level, analogously to the career categories.

Career interests. A 205 item interest inventory with 17 scales was administered in 1960 and 1963. The primary scales used in the present study were "Physical Science, Math, and Engineering Interest" and "Interest in Office work." In addition, four items relating specifically to mathematics were combined to form a measure of interest in math itself.

Findings

The complete findings of the present study are reported in detail in the project's technical report to the National Institute of Education, which is currently undergoing final revision. The basic findings relating to the importance of high school math participation for math achievement in high school and for subsequent career success are summarized below. They are organized around six questions of summary interest to the study.

1. To what extent were sex differences in math achievement evident during the high school years?

Figure 1 shows the mean math achievement scores for males and females in each high school grade. The difference in the male and female means among 9th graders, while statistically significant because of the very large sample size, was less than .07 standard deviation which was too small to be of much practical significance. (The results in Figure 1 were based on a 10% sample of all 1960 cases containing just under 5,000 cases for each sex and grade. The appropriate t statistic was 6.8.) The male gains in math achievement during high school were more than twice the female gains. Sex differences in math achievement increased most sharply after the 10th grade, the time at which mathematics courses became truly elective.

Figure 1 presents cross-sectional data. Some of the "gain" in math achievement could well be due to differential dropout rates with respect to math scores. However, almost exactly the same results were obtained from the sample of roughly 3,500 cases who were given the math achievement test in both the 9th and 12th grades. The males in this sample gained

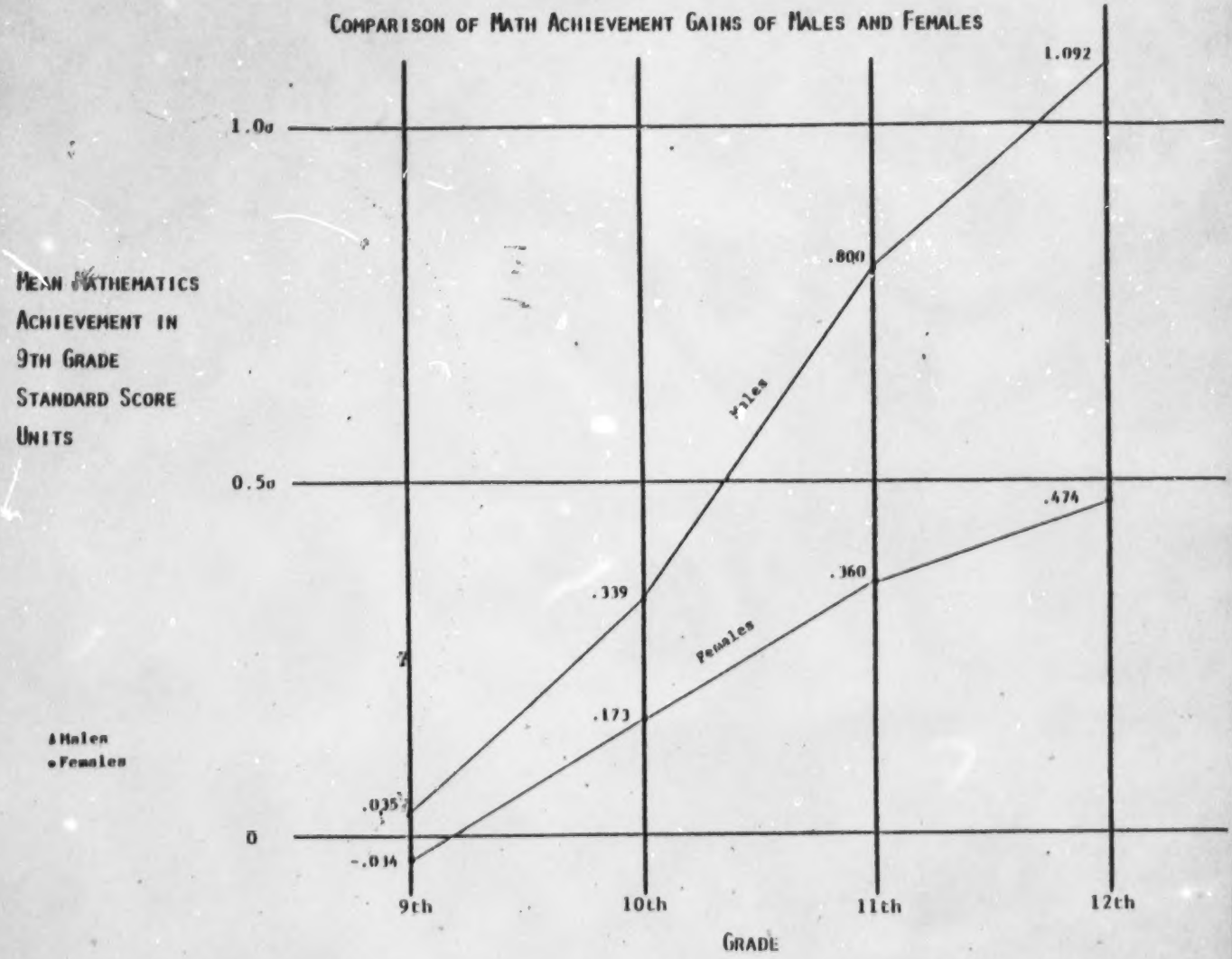

Figure 1. WHEN DO SEX DIFFERENCES IN MATH ACHIEVEMENT OCCUR?

.98 standard deviations while the female gain was less than .47 standard deviations. In both cases, the male gains were more than twice the female gains and by 12th grade the males averaged more than one-half a standard deviation higher than the female.

2. To what extent could sex differences in math achievement during high school be attributed to sex differences in participation in elective math courses?

The two strongest predictors of 12th grade math achievement were 9th grade math achievement (r= .78) and the amount of math taken in high school (r= .73). Ninth grade math achievement is, indeed, a powerful predictor, as higher 9th grade scores were associated with higher raw gain scores, so that individual differences tended not only to remain consistent, but actually tended to increase. The opposite was true for other measures, such as Reading Comprehension or English, where there was some tendency for students with lower scores to "catch up."

The positive correlation between 9th grade achievement and raw gain scores is undoubtedly related to the fact that students with higher 9th grade scores had a much higher rate of participation in elective math courses than their classmates (r= .62). Nonetheless, for students who took the same amount of math, their initial abilities were highly predictive of their final level of achievement (the correlation pooled within level of math taken and sex was .55; the partial correlation controlling for amount of math taken was .60). On the other hand, the amount of math taken also had a strong effect on 12th grade math achievement, independent of initial abilities (a partial correlation of .44).

The amount of math taken and 9th grade math achievement together have a multiple correlation of .84 with 12th grade math achievement, accounting for just over 70% of the variation. The multiple correlation begins to approach the reliability of the 12th grade math achievement measure (an upper bound), which was estimated by Shaycoft (1967, p. 4-20) at .93 for males and .91 for females. Nevertheless, there are a number of variables that account for significant amounts of the remaining variation, as discussed below.

Figure 2 shows 12th grade math achievement by the amount of math taken for each sex. In order to assess the extent to which sex differences in

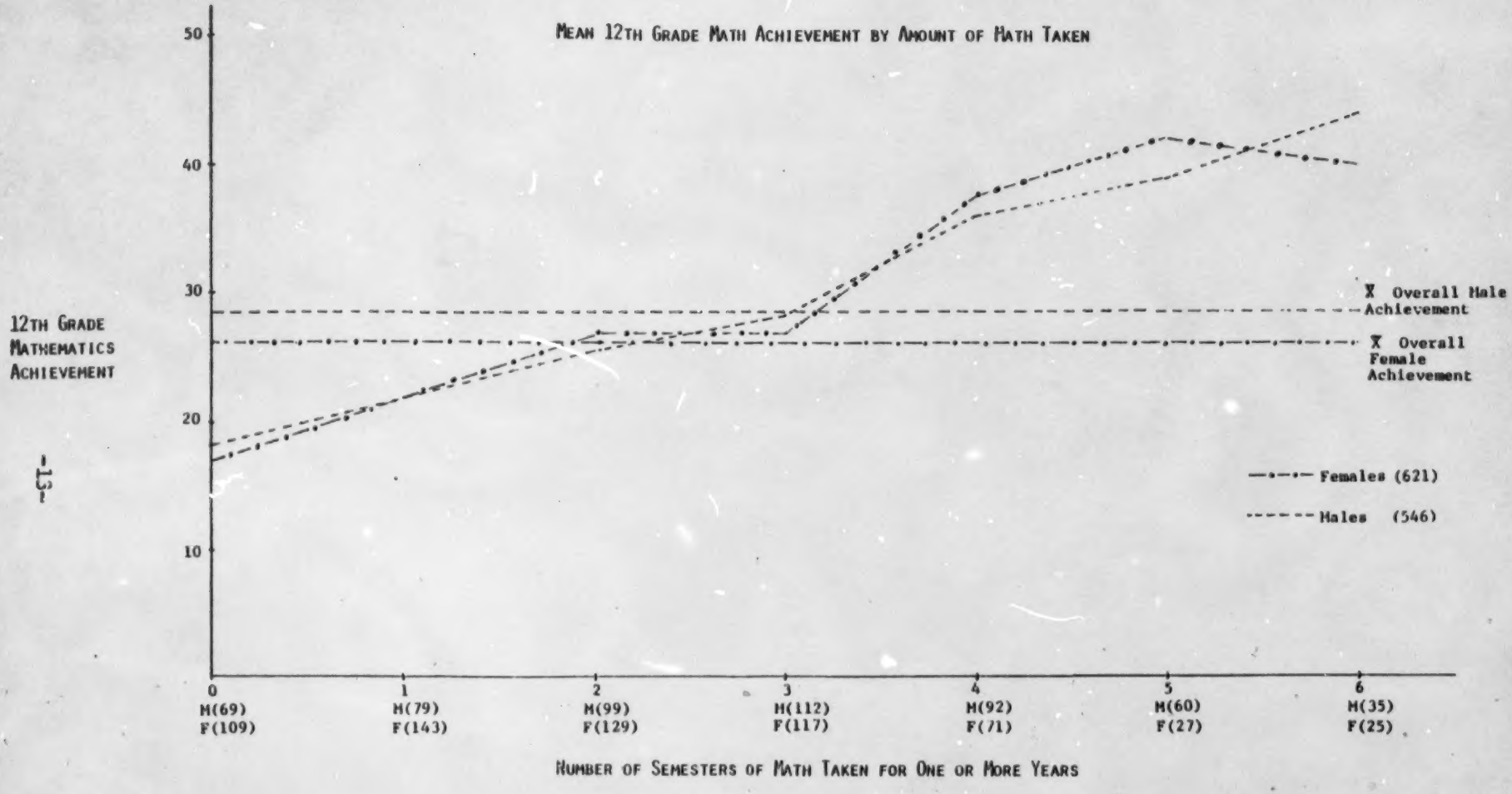

Figure 2. Effect of Math Participation Rates on Math Achievement

12th grade achievement could be explained by differences in math participation, a 2-way ANOVA with sex and amount of math taken as the independent factors were performed. Table 3 shows the results. The sex differences were literally nonexistent after controlling for amount of math taken, although there is a small interaction effect, with women scoring higher at moderate levels of math taken and males scoring higher at the extremes.

These results are, however, somewhat misleading, since they do not also include controls for initial abilities. Females who took advanced high school math were a more select group than males with the same level of participation. They tended to have higher levels of math ability to begin with. Table 4 shows another 2-way analysis of variance (sex X math taken) with 9th grade achievement controlled as a covariate. The results indicate that females with math participation and math ability equal to males had scores which averaged .1 standard deviations (based on 12th grade achievement scores) lower than male scores.

While this difference is significant, it is not large. Math taken and 9th grade achievement account for 71.1% of the variation in 12th grade achievement. Sex can account for 1.6% of the variation of 12th grade achievement when other factors are not controlled. However, sex accounts for only an additional 0.2% of the variance of 12th grade achievement when math taken and 9th grade achievement are controlled. In this sense, roughly seven-eights of the relationship between sex and 12th grade math achievement can be attributed to math taken and initial achievement.

3. To what extent could sex differences in math participation and achievement during high school be accounted for by differences in abilities, interests, and plans already evident in ninth grade?

A general model for math achievement was developed in two stages. First, variables that explained differences in achievement gains after controlling for level of participation and initial ability were examined. Then a model for predicting level of math participation from ninth grade characteristics was developed.

After a series of exploratory regression analyses, three factors were identified as predictive of math achievement gains within level of math participation. These were:

TABLE 3

Two-way Analysis of Variance of 12th Grade Math Achievement

by Sex and Amount of Math Taken

* * * * * * * * * * ANALYSIS OF VARIANCE * * * * * * * * * *

BY340 (12TH GRADE MATH ACHIEVEMENT)
BY SEX
MATHTKN (AMOUNT OF MATH TAKEN)

* *

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	65895.750	7	9413.676	202.065	0.001
SEX	1.064	1	1.064	0.023	0.999
MATHTKN	63821.520	6	10636.918	228.322	0.001
2-WAY INTERACTIONS	692.000	6	115.333	2.476	0.022
SEX MATHTKN	692.023	6	115.337	2.476	0.022
EXPLAINED	66587.750	13	5122.133	109.947	0.001
RESIDUAL	53715.312	1153	46.587		
TOTAL	120303.062	1166	103.176		

1210 CASES WERE PROCESSED.
43 CASES (3.6 PCT) WERE MISSING.

* * * MULTIPLE CLASSIFICATION ANALYSIS * * *

* *

GRAND MEAN = 27.16

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA	ADJUSTED FOR INDEPENDENTS + COVARIATES DEV'N	ADJUSTED FOR INDEPENDENTS + COVARIATES BETA
SEX							
1	546	1.42		-0.03			
2	621	-1.25		0.03			
			0.13		0.00		
MATHTKN							
1	178	-9.54		-9.54			
2	222	-6.17		-6.18			
3	229	-2.44		-2.44			
4	229	0.79		0.79			
5	163	9.20		9.21			
6	87	12.12		12.13			
7	60	14.81		14.82			
			0.74		0.74		
MULTIPLE R SQUARED					0.548		
MULTIPLE R					0.740		

TABLE 4

Two-Way Analysis of Covariance of 12th Grade Math Achievement by Sex and Amount of Math Taken Controlling for 9th Grade Math Achievement

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

BR340 (12TH GRADE MATH ACHIEVEMENT)
BY SEX
MATHTKN (AMOUNT OF MATH TAKEN)
WITH AMTHTOT(9TH GRADE MATH ABILITY)

* *

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	83041.375	8	10380.172	350.018	0.001
SEX	271.084	1	271.084	9.141	0.003
MATHTKN	11484.086	6	1914.014	64.540	0.001
AMTHTOT (COVAR)	18977.605	1	18977.605	639.922	0.001
2-WAY INTERACTIONS	139.687	6	23.281	0.785	0.999
SEX MATHTKN	139.739	6	23.290	0.785	0.999
EXPLAINED	83181.062	14	5941.504	200.347	0.001
RESIDUAL	33096.250	1116	29.656		
TOTAL	116277.312	1130	102.900		

COVARIATE	BETA
AMTHTOT	0.546

1210 CASES WERE PROCESSED.
79 CASES (6.5 PCT) WERE MISSING.

* * * MULTIPLE CLASSIFICATION ANALYSIS * * *

* *

GRAND MEAN = 27.15

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA	ADJUSTED FOR INDEPENDENTS + COVARIATES DEV'N	ADJUSTED FOR INDEPENDENTS + COVARIATES BETA
SEX							
1	533	1.44				0.53	
2	598	-1.28				-0.47	
			0.13				0.05
MATHTKN							
1	174	-9.43				-4.64	
2	216	-6.21				-3.66	
3	222	-2.30				-1.41	
4	216	0.55				0.17	
5	159	9.29				4.77	
6	84	12.01				7.23	
7	60	14.82				8.49	
			0.74				0.41
MULTIPLE R SQUARED							0.714
MULTIPLE R							0.845

- general academic aptitude, which includes both math and non-math aptitude and ability measures.

- interests in mathematics together with an expected occupation that requires math and a low interest in office work.

- low levels of participation in extracurricular activities in 9th grade.

The above three variables together with math participation and 9th grade math achievement form a general model for math achievement in high school. The essential ingredients of this model are:

- ability - including a foundation of knowledge of basic math concepts and also general academic skills

- participation - exposure to math curriculum by enrolling in appropriate math courses and the lack of extensive extra-curricular involvements that might detract from participation in the courses taken

- motivation - interest in math and math-related careers relative to interests in other careers.

Table 5 shows the results of the step-wise regression analysis that includes the variables in the general model.

While the general model applied to both males and females, a few significant sex differences were observed in searching for additional predictor variables. Males who had higher levels of Spatial Visualization and those who scored higher on Table Reading tended to show larger than expected achievement gains. This is consistent with the notion that males tend to use a spatial approach to math learning more than females. Scientific attitude (essentially a belief in lawfulness) and electricity and electronics knowledge were also significant predictors of math achievement for males.

For females, Socioeconomic Status and a number of related variables (low immediate concern with Earning a Living, high Law and Sports information) were significant predictors of math achievement. In addition, Self Confidence was a much more significant predictor of math achievement for females than for males. This result is consistent with current widespread efforts to increase female math achievement through anxiety reduction (Tobias, 1976; Tobias and Donady, 1977).

TABLE 5

Three-Step Regression of 12th Grade Math Achievement on Key Background and 9th Grade Characteristics

Step	Multiple R^2	Variables in the Equation			Other Variables		
		Variable	Beta	F	Variable	Partial R.	F
One	.719	Amount of Math Taken	.396	345.1	Sex	-.162	26.8
		9th Grade Math Achievement	.301	69.0	Math Level of Expected Occupation	.160	26.1
		9th Grade General Academic Aptitude	.263	58.2	Interest in Math	.143	20.8
					Interest in Office Work	-.123	15.3
					Degree of Participation in Extracurricular Activities	-.096	9.2
					Socioeconomic Status	.072	5.2*
Two	.733	Amount of Math Taken	.332	215.6	Degree of Participation in Activities	-.107	11.4
		9th Grade Math Achievement	.232	39.2	Socioeconomic Status	.072	5.2*
		9th Grade General Academic Aptitude	.326	87.0	Sex	-.056	3.2*
		Interest in Math	.092	20.8			
		Math Level of Expected Occupation	.046	5.1*			
		Interest in Office Work	-.067	12.0			
Three	.736	Amount of Math Taken	.341	226.5	Socioeconomic Status	.090	8.1
		9th Grade Math Achievement	.225	37.3	Sex	-.042	1.8*
		9th Grade General Academic Aptitude	.321	84.7			
		Math Level of Expected Occupation	.052	6.3			
		Interest in Office Work	-.058	8.9			
		Interest in Math	.098	23.4			
		Degree of Participation in Extracurricular Activities	-.057	11.4			

* Not significant at the .01 level (Based on an N of 1164).

While there are some significant sex differences in the residual factors that predict math achievement, it should be noted that none of these factors add even 1% to the percent of variation accounted for by the general model. Table 6 gives some further perspective on the relative contribution of various factors to sex differences in math achievement. Differences in the amount of math taken are by far the most significant component of math achievement differences. Interests in math and math-related careers relative to interest in office work also play a very significant role. Any intervention that does not affect one or both of these factors is unlikely to have a very large effect in reducing sex differences in achievement levels.

The next step was to examine predictors of math participation. As with 12th grade math achievement, the largest correlate of the amount of math taken was 9th grade math achievement (r= .62). For individuals with equal initial achievement, their expected educational attainment was the most significant predictor of level of math participation (with a partial correlation of .39). The variable educational expectations accounts for an additional 9% beyond variation accounted for by 9th grade math achievement of the variance of 12th grade math achievement. However, since sex differences in both math achievement and educational expectations are relatively small in the 9th grade, neither of these factors accounts for very much of the sex differences in math participation.

Several other variables that predict math participation after controlling 9th grade achievement and educational expectations explain the significant sex differences in math participation. These are measures of interest in math-related careers relative to interest in office work and interest in math itself.

The final regression equation for predicting math participation is shown in Table 7. It includes one additional variable, intention to take a college preparatory program, which is closely related to educational expectations. Table 7 also shows that sex differences in the interest variables account for most of the sex differences in participation.

TABLE 6

Sex Differences in Math Achievement Predicted by Each Variable in the General Regression Equation

Predictor Variable	Mean Sex Difference in Predictor Variable	Regression Coefficient	Predicted Sex Difference	% of Actual Sex Difference
9th Grade Math Achievement	.376	.236	.089	3.5%
Amount of Math Taken	.602	2.041	1.229	47.8%
General 9th Grade Academic Aptitude	-23.303	.032	-.746	-29.0%
Math Level of Expected Occupation	1.574	.371	.584	22.7%
Interest in Math	4.585	.089	.408	15.9%
Interest in Office Work	-10.217	-.058	.593	23.1%
Degree of Extracurricular Activity	-2.144	-.038	.081	3.2%
Total Sex Predicted Difference			2.238	87.2%
Actual Sex Difference			2.569	
Amount Explained by Other Factors			.331	12.8%

Multiple Correlation = .86

Variance Accounted for = 74%

TABLE 7

Sex Differences in Math Participation Predicted by Each Variable in the General Regression Equation

Predictor Variable	Mean Sex Difference in Predictor Variable	Regression Coefficient	Predicted Sex Difference	% of Actual Sex Difference
9th Grade Math Achievement	.376	.065	.024	4.0%
Expected Level of Education	.231	.264	.061	10.1%
College Preparatory Curriculum	.048	.475	.023	3.8%
Interest in Math	4.584	.022	.101	16.8%
Interest in Math-Related Careers	9.301	.015	.140	23.3%
Interest in Office Work	-10.217	-.015	.153	25.4%
Total Predicted Sex Difference			.502	83.4%
Actual Sex Difference			.602	
Difference Resulting from Other Factors			.100	16.6%

Multiple Correlation = .73

Variance Accounted for = 53%

4. To what extent were sex differences in the development of math-related careers reflected in sex differences along the educational paths leading to such careers?

The second phase of the study examined factors that affected the development of math-related careers during the period from 12th grade through age 29. In this phase, math-related careers were defined as those careers generally requiring some college-level math. These are the careers shown under levels 4, 5, and 6 in Table 2 above.

Since the math-related careers studied require, by definition, at least some college, the first step in examining sex differences in the development of math-related careers was to analyze sex differences in educational attainment and in the relationship between educational attainment and entry into math-related careers. Figure 3 shows the educational paths followed by the males and females in the TALENT 12th grade cohort. The proportions in Figure 3 were estimated from the 12,729 "complete data" cases in the 12th grade cohort using case weights that provide unbiased estimates of norms for all 1960 12th graders.

The results show that the proportion of 12th grade males planning to go to college was higher than the proportion of females (54% compared to 39%), but that the males with college plans were somewhat less likely to be in college one year later than females with college plans (66% compared to 75% for females with college plans). Overall the proportion of males in college one year after high school was only slightly larger than the proportion of females (41% compared to 37%). By five years after high school, the proportion of females and males having completed college were similar (26% and 22% respectively), but roughly twice as many males as females had gone on to graduate school. Between five and eleven years after high school, 18% of the males who had not previously completed college did so compared to only 4% of the females who had not previously completed college. By the time of the 11-year follow-up, sex differences in educational attainment were quite significant. In addition, even controlling for sex differences in educational attainment, males were much more likely to have followed an educational course leading to a math-related career. Only 1% of the females with a bachelors degree but not an advanced degree went into math-related careers compared to 15% of the

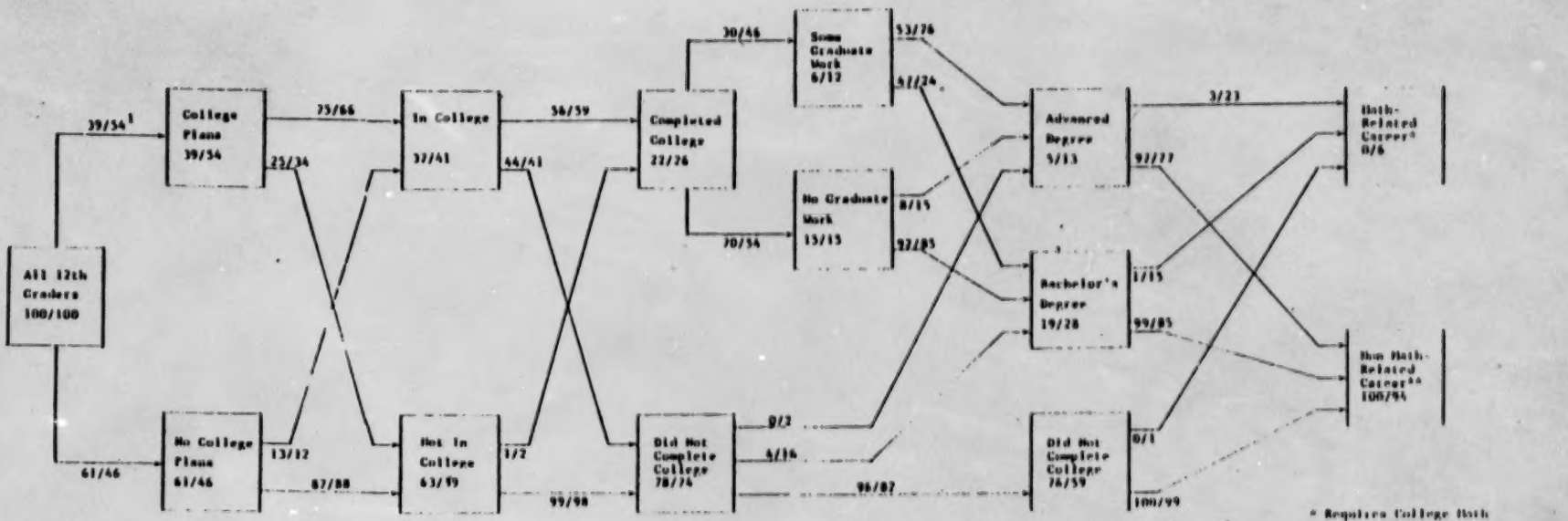

FIGURE 3. EDUCATIONAL PATHS TO MATH-RELATED CAREERS

males in this category. Similarly only 3% of the females with advanced degrees went into math-related careers compared to 23% of the males with advanced degrees.

5. How important and accurate were early career plans with respect to the development of math-related careers?

The second question concerning the development of math-related careers dealt with career planning. How essential was early career planning to eventual entry into math-related careers? How successful were those who planned, in high school, to enter a math-related career?

For these analyses, three levels of career plans were investigated: careers generally requiring college-level math; other careers generally requiring some college; and other careers that do not generally require college. Individuals with no specific career plan or no specific occupation at age 29 were excluded from the analysis as were those reporting no plan or occupation outside the home in order to make the remaining groups more comparable. Table 8 shows the relationship between career plans in 12th grade, one year later, five years later, and occupation at age 29.

The results indicate that a relatively low proportion of those who planned to enter a math-related career actually did so. More than 80% of the males and 90% of the females who planned math-related careers in 12th grade were in other kinds of careers at age 29. Even at age 19, when most of those planning science careers had completed a year of college, only a quarter of those who planned math-related careers were in math-related careers at age 29. (Note, too, that homemakers at age 29 were excluded.) Even at age 23, only half of those who planned math-related careers were successful in carrying out these plans.

The second finding concerning math-related career plans was that virtually no one who was not already planning a math-related career by 12th grade later switched into a math-related career by age 29. Even among those who were planning college-related but not math-related careers, only 3% of the males switched into math-related careers. This finding and the fact that over one-third of those planning math careers in 12th grade had changed to other career plans one year later indicate that there are

TABLE 8

Occupational Outcome at Age 29 for
each Level of Career Plan at Ages 18, 19, and 23

	% in Low Math-Level Careers		% in Intermediate Math-Level Careers		% in Math-Related Careers	
	Male	Female	Male	Female	Male	Female
Age 18 Career Plans						
Low Math-Level	85	80	15	20	0.6	0.0
Intermediate Math-Level	44	39	53	60	3.1	0.2
Math-Related	39	54	43	38	17.7	7.7
Age 19 Career Plans						
Low Math-Level	82	81	16	19	1.9	0.0
Intermediate Math-Level	34	31	63	69	3.4	0.3
Math-Related	31	18	43	57	25.7	24.7
Age 23 Career Plans						
Low Math-Level	87	87	13	13	0.5	0.0
Intermediate Math-Level	30	22	67	78	3.0	0.7
Math-Related	26	16	26	47	48.0	37.2

important early selection factors for math-related careers that both screen out a significant number of students and make it difficult for others to later change into a math-related career path.

6. To what extent was high school math achievement predictive of success in the pursuit of math-related career goals?

By 12th grade, a strong relationship between math achievement and plans regarding math-related careers is evident. The final area of investigation concerned the relationship between high school math achievement and the realization of plans to enter math-related careers made at various points in time. The data presented in Table 8 above show clearly that a significant proportion of those planning math-related careers are not working in math-related careers at age 29. The goal of these analyses was to determine the extent to which a failure to develop math skills in high school could account for their lack of success in meeting career goals.

Table 9 shows the mean math achievement scores of TALENT participants with various levels of math-related career plans in 12th grade who did or did not enter a math-related career. Those who were successful in their pursuit of a math-related career had had dramatically higher math achievement scores in 12th grade. Those who were not planning math-related careers in 12th grade, but later entered a math-related career, also had markedly higher 12th grade achievement scores than their counterparts who did not switch into math-related careers, indicating the importance of math skills for keeping career options open even if a math-related career is not explicitly planned.

Table 10 shows the same results for career plans held at approximately age 23. These results are somewhat more surprising. By age 23 nearly all of those who were planning math-related careers had completed their undergraduate education and either gone on to graduate school or entered the labor force. It would have been reasonable to suppose that skills developed during high school would be relatively unrelated to success in the development of math-related careers between age 23 and age 29. Yet those who were successful in entering math-related careers had average 12th grade math scores roughly .3 standard deviations greater than those who entered careers not requiring college math and over .7 standard deviations higher than those who were in careers requiring little or no math at all. The relationship

TABLE 9

Mean 12th Grade Math Achievement* by Math Levels of 12th Grade Career Plan and Occupation at Age 29 Math Level of 12th Grade Career Plan

Math Level of Occupation at Age 29	Mathematics Level of 12th Grade Career Plan			
	Some College Level Math	May Require Some Statistics	High School Math Only	Plan Not Classified
MALES				
Some college Level Math	1.23±.08 (509)	.69±.22 (78)	.42±.49 (16)	.63±.35 (31)
May Require Some Statistics	.83±.06 (931)	.34±.06 (1118)	-.17±.14 (195)	-.06±.13 (239)
High School Math Only	.27±.08 (583)	-.11±.08 (610)	-.47±.07 (691)	-.46±.10 (373)
Not Classified	.70±.13 (242)	.29±.16 (149)	-.39±.23 (70)	-.17±.26 (58)
Total	.76±.04 (2265)	.21±.04 (1955)	-.39±.06 (972)	-.25±.07 (701)
FEMALES				
Some College Level Math	1.29±.42 (21)	1.02±.74 (7)	.48±1.39(2)	1.25±.74 (7)
May Require Some Statistics	.96±.20 (97)	.25±.07 (820)	-.39±.12 (286)	-.06±.14 (194)
High School Math Only	-.05±.29 (46)	-.26±.11 (323)	-.62±.06 (926)	-.58±.12 (249)
Not Classified	.60±.16 (151)	-.01±.06 (1244)	-.58±.05 (1692)	-.47±.07 (752)
Total	.66±.11 (315)	.05±.04 (2394)	-.57±.04 (1906)	-.41±.06 (1202)

* In standard score units (with numbers of cases in parentheses) with approximate 95% confidence bounds.

TABLE 10

Mean 12th Grade Math Achievement* by Math Levels of Career Plan at Age 23 and Occupation at Age 29

Math Level of Occupation at Age 29	Mathematics Level of Career Plan at Age 23			
	Some College Level Math	May Require Some Statistic	High School Math Only	Plan Not Classified
MALES				
Some College Level Math	1.18±.09 (523)	1.03±.23 (75)	.50±.54 (13)	.38±.41 (23)
May Require Some Statistics	.91±.13 (224)	.49±.05 (1776)	-.02±.12 (246)	.15±.13 (237)
High School Math Only	.45±.16 (158	.10±.09 (518)	-.35±.06 (1185)	-.29±.10 (396)
Not Classified	.82±.19 (102)	.66±.15 (174)	-.16±.19 (104)	-.05±.17 (139)
Total	.97±.06 (1007)	.44±.04 (2543)	-.28±.05 (1584)	-.09±.07 (705)
FEMALES				
Some College Level Math	1.27±.38 (26)	1.05±.65 (9)	------ (1)	------ (1)
May Require Some Statistics	.87±.38 (27)	.21±.06 (1070)	-.37±.19 (105)	-.20±.14 (195)
High School Math Only	.89±.80 (6)	-.20±.14 (191)	-.50±.07 (757)	-.68±.08 (590)
Not Classified	1.18±.37 (28)	.16±.06 (1058)	-.42±.07 (725)	-.57±.04 (2028)
Total	1.09±.11 (87)	.16±.04 (2328)	-.45±.05 (1588)	-.57±.04 (2814)

* In standard score units (with numbers of cases in parentheses) with approximate 95% confidence bounds.

between high school math achievement and switching into a math-related career not planned at age 23 was even more dramatic. Those switching into math-related careers had 12th grade math scores averaging .9 standard deviations greater than those ending up in an intermediate level career.

One plausible explanation for the relationship of high school math achievement to career development after age 23 is that high school math achievement is related to events after high school which moderate the relationship of math achievement to later career development. Two potential moderators, educational attainment at age 23 and the math level of college major, were examined. For each moderator, an analysis of variance was run to test the relationship of 12th grade math achievement to math level of occupation at age 29 when both the math level of the career plan at age 23 and the moderator were controlled.

Table 11 shows the ANOVA results when educational attainment at age 23 is controlled. This analysis was inclusive in that individuals who were not planning careers outside the home at age 23 or were not working outside the home at age 29 was statistically significant, although not large in a practical sense. The inclusive nature of the analyses undoubtedly introduced some noise into the statistics as decisions regarding homemaking or unemployment are likely to be independent of ability. Those who did end up in a math-related career had averaged between .25 and .35 standard deviations higher on 12th grade math achievement than those who ended up with careers at the intermediate level.

Table 12 shows the ANOVA results when the math level of college major is controlled. For contrast, this analysis was exclusive, limited to college attenders who planned careers outside the home at age 23 and were working outside the home at age 29. Again 12th grade math achievement was significantly related to occupational outcome at age 29 even after career plan at age 23 and college major were controlled. Those who did end up in math-related careers had averaged more than .3 standard deviations higher on the 12th grade math achievement test than those who had the age 23 career plans and a college major at the same level, but ended up in another college-related career.

TABLE 11a

12th Grade Math Achievment (R340) by Occupation at Age 29 (DOCCMTH), Career Plan at Age 23 (CCPLNMTH) and Amount of Education at Age 23 (CAMTED) - Males

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	239486.187	9	26493.465	349.537	0.001
DOCCMTH	3215.031	3	1071.677	14.138	0.001
CCPLNMTH	9199.255	3	3066.418	40.450	0.001
CAMTED	84919.062	3	28306.352	373.438	0.001
2-WAY INTERACTIONS	2771.062	27	102.632	1.354	0.104
DOCCMTH CCPLNMTH	1360.746	9	151.194	1.995	0.036
DOCCMTH CAMTED	927.569	9	103.508	1.352	0.203
CCPLNMTH CAMTED	492.472	9	54.719	0.722	0.999
3-WAY INTERACTIONS	3441.875	24	132.380	1.746	0.011
DOCCMTH CCPLNMTH CAMTED	3441.902	26	132.381	1.746	0.011
EXPLAINED	244699.125	62	3946.760	52.069	0.001
RESIDUAL	419321.625	5532	75.799		
TOTAL	664020.750	5594	118.702		

5893 CASES WERE PROCESSED.
298 CASES (5.1 PCT) WERE MISSING.

* *

GRAND MEAN = 31.91

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA
Occupation at Age 29 (DOCCMTH)					
0. Unclassified	447	0.98		0.96	
1. Low Math Level	2132	-4.96		-0.75	
2. Intermediate Level	3307	1.93		-0.14	
3. Math-Related	804	9.14		2.44	
			0.41		0.09
Career Plan at Age 23 (CCPLNMTH)					
0. Unclassified	791	-3.91		-1.22	
1. Low Math Level	1467	-6.10		-1.38	
2. Intermediate Level	2446	1.87		-0.18	
3. Math-Related	951	7.61		3.54	
			0.44		0.15
Amount of Education (CAMTED)					
1. No College	1472	-8.91		-7.34	
2. Some College	1875	-0.54		-0.56	
3. Bachelors only	1057	4.43		3.78	
4. Some Grad Work	1193	7.91		6.59	
			0.57		0.47
MULTIPLE R SQUARED					0.359
MULTIPLE R					0.599

TABLE 11b

12th Grade Math Achievment (R340) by Occupation at Age 29 (DOCCMTH), Career Plan at Age 23 (CCPLNMTH) and Amount of Education at Age 23 (CAMTED) - Females

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	192497.750	9	21388.637	327.636	0.001
DOCCMTH	714.364	3	238.121	3.648	0.012
CCPLNMTH	6644.293	3	2214.764	33.926	0.001
CAMTED	80471.312	3	26823.770	410.893	0.001
2-WAY INTERACTIONS	6248.000	26	240.308	3.681	0.001
DOCCMTH CCPLNMTH	857.254	9	95.250	1.459	0.156
DOCCMTH CAMTED	1018.542	8	127.318	1.950	0.048
CCPLNMTH CAMTED	3195.337	9	355.037	5.439	0.001
3-WAY INTERACTIONS	1729.062	19	91.003	1.394	0.117
DOCCMTH CCPLNMTH CAMTED	1729.104	19	91.005	1.394	0.117
EXPLAINED	200474.812	54	3712.496	56.869	0.001
RESIDUAL	421001.687	6449	65.282		
TOTAL	621476.500	6503	95.568		

6917 CASES WERE PROCESSED.
313 CASES (4.6 PCT) WERE MISSING.

* *

GRAND MEAN = 95.43

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA
Occupation at Age 29 (DOCCMTH)					
0. Unclassified	3490	-0.67		0.13	
1. Low Math Level	1446	-2.81		-0.49	
2. Intermediate Level	1343	4.44		0.07	
3. Math-Related	224	15.47		3.66	
			0.26		0.04
Career Plan at Age 23 (CCPLNMTH)					
0. Unclassified	2457	-2.33		-0.83	
1. Low Math Level	1405	-1.94		0.32	
2. Intermediate Level	2239	4.76		0.46	
3. Math-Related	84	15.31		5.86	
			0.41		0.12
Amount of Education (CAMTED)					
1. No College	3071	-5.00		-4.57	
2. Some College	1494	0.87		0.90	
3. Bachelors only	1275	6.38		5.85	
4. Some Grad Work	659	8.96		7.92	
			0.54		0.49
MULTIPLE R SQUARED					0.310
MULTIPLE R					0.557

TABLE 12a

12th Grade Math Achievment (R340) by Occupation at Age 29 (DOCCMTH), Career Plan at Age 23 (CCPLNMTH) and Math Level of College Major (CMAJMTH) - Males

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	41525.834	6	6920.973	83.523	0.001
DOCCMTH	6306.539	2	3153.270	38.056	0.001
CCPLNMTH	1602.433	2	801.217	9.670	0.001
CMAJMTH	9490.969	2	4745.484	57.272	0.001
2-WAY INTERACTIONS	779.066	13	59.851	0.722	0.999
DOCCMTH CCPLNMTH	289.084	5	57.817	0.698	0.999
DOCCMTH CMAJMTH	124.588	4	31.147	0.376	0.999
CCPLNMTH CMAJMTH	320.796	4	80.199	0.968	0.999
3-WAY INTERACTIONS	320.152	7	45.736	0.552	0.999
DOCCMTH CCPLNMTH CMAJMTH	320.153	7	45.736	0.552	0.999
EXPLAINED	42624.062	26	1639.387	19.785	0.001
RESIDUAL	248077.875	2994	82.858		
TOTAL	290701.937	3020	96.259		

3020 CASES WERE PROCESSED.
2897 CASES (48.9 PCT) WERE MISSING.

* *

GRAND MEAN = 38.89

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA
Occupation at Age 29 (DOCCMTH)					
1. Low Math Level	484	-8.29		-2.44	
2. Intermediate Level	1780	-0.54		0.00	
3. Math-Related	555	5.82		3.03	
			0.30		0.18
Career Plan at Age 23 (CCPLNMTH)					
1. Low Math Level	277	-4.15		-1.97	
2. Intermediate Level	1865	-1.04		-0.05	
3. Math-related	779	4.50		1.09	
			0.29		0.09
Math Level of Major (CMAJMTH)					
1. Low Math Level	484	-1.81		-1.36	
2. Intermediate Level	1341	-2.65		-1.83	
3. Math-Related	1196	3.70		2.60	
			0.31		0.22
MULTIPLE R SQUARED					0.143
MULTIPLE R					0.378

TABLE 12b

12th Grade Math Achievment (R340) by Occupation at Age 29 (DOCCMTH), Career Plan at Age 23 (CCPLNMTH) and Math level of College Major (CMAJMTH) - Females

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	10819.180	6	1803.197	22.161	0.001
DOCCMTH	826.713	2	413.356	5.080	0.006
CCPLNMTH	923.938	2	461.969	5.677	0.004
CMAJMTH	3442.709	2	1721.354	21.155	0.001
2-WAY INTERACTIONS	1182.215	12	98.518	1.211	0.269
DOCCMTH CCPLNMTH	339.982	5	67.796	0.833	0.999
DOCCMTH CMAJMTH	404.561	3	134.854	1.657	0.173
CCPLNMTH CMAJMTH	440.723	4	110.181	1.354	0.247
3-WAY INTERACTIONS	346.363	3	122.121	1.501	0.211
DOCCMTH CCPLNMTH CMAJMTH	346.365	3	122.122	1.501	0.211
EXPLAINED	12367.812	21	588.943	7.238	0.001
RESIDUAL	104803.500	1288	81.369		
TOTAL	117171.312	1309	89.512		

6951 CASES WERE PROCESSED.
5541 CASES (80.9 PCT) WERE MISSING.

* *

GRAND MEAN = 31.40

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA
Occupation at Age 29 (DOCCMTH)					
1. Low Math Level	299	-2.33		-1.50	
2. Intermediate Level	979	0.37		0.32	
3. Math-Related	32	10.43		4.32	
			0.21		0.11
Career Plan at Age 23 (CCPLNMTH)					
1. Low Math Level	714	-2.71		-0.91	
2. Intermediate Level	1044	0.09		-0.06	
3. Math-related	50	9.82		5.15	
			0.23		0.11
Math Level of Major (CMAJMTH)					
1. Low Math Level	422	0.81		0.88	
2. Intermediate Level	685	-1.86		-1.48	
3. Math-Related	202	4.61		3.19	
			0.24		0.18
MULTIPLE R SQUARED					0.092
MULTIPLE R					0.304

The results of these analyses indicate that the selection process for math-related careers continued well past age 23. Math skills developed during high school were important predictors of success in completing an undergraduate math-related major, but these skills continued to be important in the selection process after age 23, independent of educational attainment or college major at that time.

Summary and Conclusions

The goal of this study was to identify factors that were important in the development of math-related careers, particularly those factors that have screened out a disproportionate number of women. The main focus was on the role of achievement in mathematics during high school, which has been suggested to be a critical barrier for women.

The findings emphasize the importance of early planning for math-related careers. Very few of those who were not planning a math-related career in 12th grade later switched into a math-related career. Math skills were, of course, highly correlated with math-related career plans, but they were also an important predictor of success in carrying out math-related career plans. Similarly, math skills developed during high school were both an essential component of subsequent educational attainment and a significant predictor of success in establishing math-related careers independent of level of educational attainment. High school math achievement played a significant role in the development of math-related careers over the entire period from high school to age 29.

Only minimal sex differences in math achievement were observed in 9th grade, but dramatic sex differences were measured in math achievement gains during the high school years. These differences were attributable to a greater participation by males in elective math courses and a greater male interest in math-related careers. The sex differences in math participation during high school were also found to be closely related to sex differences in career interests already evident in 9th grade.

The results of this study point out the vital importance of early interests and plans in the development of math-related careers. Sex differences in interest in and planning for math-related careers were found to clearly precede differences in math achievement. If females are to maintain their options for pursuing math-related careers, it is important that emphasis be given to career education prior to high school.

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